THOMAS (A.R.)

EVOLUTION

OF THE

EARTH AND MAN

A Lecture before the Hahnemannian Institute of the Students of the Hahnemann Medical College of Philadelphia, February 3d, 1892.

BY

A. R. THOMAS, M.D.,

Professor of Anatomy.

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PHILADELPHIA, PA., March 3, 1892.

Prof. A. R. Thomas, M.D.

DEAR DOCTOR: A general desire having been expressed by the students of Hahnemann Medical College to procure copies of your lecture on Evolution, delivered before the Hahnemannian Medical Institute at the February meeting, the undersigned, a committee representing the Institute, respectfully request the loan of your manuscript for publication.

Hoping for a favorable response, we remain,

Very respectfully, etc.,

J. C. FOSTER, *Chairman*, KY., '92.
J. L. VAN TINE, JR., PA., '93.
W. D. CARTER, PA., '94.
Committee.

PHILADELPHIA, March 4, 1892.

Messrs. Foster, Van Tine, Jr., & Carter.

GENTLEMEN: Your communication of the 3d inst., requesting a copy of my recent lecture before your Society, for publication, has been received. In compliance with your wishes, I herewith place the manuscript at your disposal.

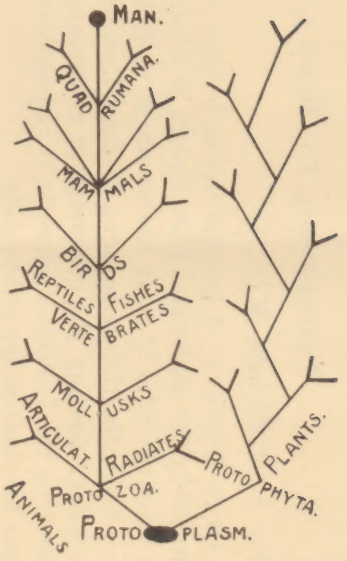
With best wishes, both for yourselves and your classmates, I am

Yours truly,

A. R. THOMAS, M.D.

EVOLUTION OF THE EARTH AND MAN.

Ages.	*Geological Strata.*	*Fossil Remains.*	*Diagram of Development of Animals and Plants from an Original Organic Cell.*
Post-tertiary or Quaternary Age. Age of Man.	RECENT Period. GLACIAL Period.	Steel or present Age. Iron Age Bronze Age } Man. Stone Age	
Tertiary or Cainozoic Age. Recent Animals.	PLIOCENE, 3,000 ft. MIOCENE, 500 ft. EOCENE, 1,700 ft.	Placental Mammals. Bimana, first trace. Quadrumana Chiroptera. Carnivora Insectivora. Omnivora Ruminantia. Rodentia Proboscidia. Cetacea Edentate.	
Secondary or Mesozoic Age. Intermediate Animals.	CRETACEOUS, 2,500 ft. JURASSIC, 4,000 ft. Oolite. TRIASSIC, 5,000 ft. New Red Sandstone.	Monotremata, Marsupials, implacental mammals, bony fishes, birds, numerous flying reptiles, birds with teeth, monster reptiles now extinct, snakes, crocodiles, turtles.	
Primary or Palæozoic Age. Ancient Animals.	PERMIAN, 3,500 ft. CARBONIFEROUS, 15,000 ft. Coal Fields. DEVONIAN, 16,000 ft. Old Red Sandstone. SILURIAN, 18,000 ft. CAMBRIAN, 25,000 ft.	Batrachians, Reptiles, first trace. Cartilaginous Fishes. Vertebrates. Articulates. Mollusks. Radiates. Protozoa.	
Azoic Age. No Animals.	Fundamental Rocks. Granite Gneiss, etc.	Unknown thickness. No fossils.	



Internal Fires.

EVOLUTION OF THE EARTH AND MAN.

MR. PRESIDENT, LADIES AND GENTLEMEN:

The age in which we live is one of the most remarkable in the world's history. Those of us whose memories may carry us back fifty or more years can recall the announcement of all the great discoveries and inventions of the century. We have seen the most rapid advance in all the arts and sciences, and have witnessed a progress in every department of knowledge that has never before been approximated in the same period of time. The employment of steam and electricity has changed the occupation of men, influenced every industry, revolutionized all the methods of trade, and so annihilated space and time as to have made all nations our neighbors, and to have brought the whole world into such close relations and into such unity of interests as has never been experienced before. Thought has been quickened, invention stimulated, investigation has been extended in every direction, and the sum of human knowledge vastly increased. Science has extended our knowledge upward and outward into the illimitable distances of the universe, as

well as downward in the direction of the infinitesimals of matter and life.

Of the many scientific developments of the past half century, that which has perhaps attracted the widest attention and given rise to the most heated controversies—that has, more than any other, tended to revolutionize our views of the great questions of nature and of man—is the doctrine of Evolution. Although foreshadowed by some of the writers of the latter part of the past and the beginning of the present century, it has only been within the past thirty years that the doctrine has been clearly formulated and presented to the world. Whatever missing links there may be in the chain of evidence for the support of this doctrine, however repugnant it may be to our estimate of the dignity of man, however the theory may conflict with our earlier teachings, Evolution, nevertheless, has been received with such a degree of favor by the scientific world as to leave no question as to the permanency of its endurance.

It is a common but erroneous idea, that Evolution is a theory relating only to the descent of man from the monkey, and that Charles Darwin was its author. On the contrary, Evolution is a doctrine which relates to the origin of the whole universe as well as of man—one that has required a full century to bring to its present state of development. Long before Darwin published his "Origin of Species" and "Descent of Man," Kant and La Place, in the last century, had worked out the

development of the stellar worlds from the thin vapor of nebulous matter, Lyall had demonstrated the evolution of our earth's surface to its present condition, Lamarck had suggested the descent of plants and animals from common ancestors by slow modifications, and Herbert Spencer had worked out the growth of mind from its simplest beginning to its highest development in human intellect. Darwin, following in 1857 with his "Theory of Natural Selection," prepared the way for the construction of a grand system of philosophy to which Spencer first gave the name of Evolution.

Three principal theories have been entertained by men relating to the origin of our earth and its inhabitants. The first taught that the whole universe, with the earth and its occupants, has existed from all eternity. This was the theory of the ancients. It was without support of reason or fact, and was long ago abandoned.

The second theory taught that the sun, moon and stars with our earth, in much the same condition as we find it to-day, with the vegetable and animal kingdoms, including man, were created a few thousand years ago in the short space of six days. This is the Mosaic theory, one generally accepted as of Divine authority, and still in a modified form held largely by the Christian world.

The third theory teaches that, instead of a sudden creation, there has been a gradual development of the

whole universe, including our earth and everything therein; that every change has been the result of slowly-acting forces, and that every new form of vegetable or animal has descended from those previously existing, and that, instead of six days, millions of cycles of ages—a period of time of which the mind can form but the faintest conception—have been required to produce what we see to-day. This is the doctrine of evolution, a theory to the consideration of which I am to call your attention this evening.

What are we to understand by the term evolution as employed in connection with this theory? One or two familiar examples will serve to illustrate. We may place in the soil the seed of a plant. Wonderful results follow. The seed swells and germinates. A rootlet forms and is directed downward. A stem appears, shoots upward, and finally reaches the surface. Leaves form, branches are thrown out, and finally a flower appears, wonderful in construction, and beautiful in form and coloring. A seed-vessel forms at its base, an ovule is developed, the pollen of the stamens is carried down the canal of the pistil, the ovule is impregnated, and the fertile seed is perfected.

Another illustration. Let us note the main facts relating to the development of the egg. Commencing as a microscopic germ, under the required conditions we find a gradual segmentation taking place, resulting in an indefinite multiplication of cells; these by modification of form and change of relation form tissues;

tissues expand and, by various adaptations, form organs, feebly outlined at first, but gradually becoming perfected in every detail and prepared to assume their peculiar functions. Deriving its nourishment either directly from its mother, as in mammals, or from the nutriment stored up with the germ, as in birds, the egg thus gradually develops into an embryo, the embryo into a fœtus, the fœtus finally reaching a degree of development enabling it to maintain an independent existence, when, bursting its shell or expelled from the womb of its mother, respiration is immediately established, and all the functions essential for life are started into harmonious action.

Such is evolution—an unfolding—a growth—a gradual development—each step in the process being the natural sequence of conditions previously existing. The principle is not confined simply to the development of the vegetable and animal kingdoms, but applies as well to the inorganic as to the organic world. It attempts to account for the origin of all nature, for the development, not only of man, but of language, of science, of art and of society.

The nebular theory of the origin of the universe, the first step in the great system of evolution, teaches that the matter composing all worlds—the stars, the sun and our earth—existed at one time as a vast sea of extremely attenuated vapor filling all space. Slowly aggregating around numerous centres, these separate masses gradually condensed into suns and planetary

worlds. Thus our own solar system, including the matter composing the sun, with the several planets and our earth, according to the theory of Kant and La Place, formed originally one revolving mass of intensely hot vapor, filling or even extending beyond the orbit of Neptune, our most distant planet—a space more than five billions of miles in diameter.

From the well-known tendency of revolving bodies to throw off portions at a tangent, from time to time, masses of this fiery vapor, by centrifugal force, were detached from the central body and sent whirling into space. Checked in their onward course only by the opposing force of gravity, they finally established for themselves orbits around the central mass, all nearly in the same plane, and all revolving in the same direction in their orbits as well as on their axes.

Thus our earth with its several accompanying planets formed at one time a portion of the sun, while our moon as well as the satellites of the several planets have all been thrown off from their primaries while still in their original gaseous state.

Such is an outline of the evolution of our solar system, an hypothesis satisfactorily accounting for most of the facts of cosmogony, and almost universally accepted by astronomers and scientists of the present day.

In the further evolution of our earth, the gradual cooling and condensing of the fiery mass, after the lapse of innumerable ages, resulted in the formation of a solid crust of crystalline rock. Still slowly cool-

ing, the enclosing crust gradually increased in thickness, and, from the shrinking of the central mass, was thrown up at numerous points into long ranges of hills and mountains. Thus were formed the oldest, the fundamental or azoic, rocks of the earth's crust. Everywhere much disturbed in their relations, greatly crumpled and fractured, it was from the disintegrated ruins of these rocks that the overlying, stratified formations have since been mainly constructed.

In time vapors appeared in the atmosphere, rains fell, and the accumulating waters formed streams, lakes and oceans. Still the conditions essential for life were not present, and not a living thing, plant or animal, could have been seen upon the face of the entire earth. The ages rolled on, the lapsing time to be estimated by millions of years. The solid rocks, by the action of the waters and atmospheric influences, were slowly disintegrated, and the sandy particles carried by the streams and precipitated to the bottom of the oceans, where, through the influence of pressure and heat, were formed the earliest stratified or aqueous rocks of the Cambrian period, thousands of feet in thickness. The ocean beds were finally lifted by internal forces, becoming dry land; the continents became submerged, and the processes of denudation and deposition continued. Still there was no life; not a living thing, plant or animal, could have been found upon the face of the earth. The hills and valleys were but barren and desolate wastes—no verdure covered the

plains; no blooming flowers sent forth their fragrance, no voice or sound of living thing.

Ages followed ages—subsidence and elevation were many times repeated. Disintegration continued, and the washings of the surface were carried into the seas, forming successive superimposed strata.

Finally the thickened crust of the earth so modified the temperature, and the atmosphere became so deprived of its poisonous gases as to render life possible. Matter became developed to a protoplasmic condition, and life in its simplest form, that probably of a simple cell, made its advent upon our earth. Whether this was the result of a direct creative act of Deity, or the natural outgrowth of the forces of nature, evolution does not pretend to say. However, from this simple original organic cell, gradually diverged low forms of both animal and vegetable life. From the minute and delicate character of these simple organisms, no record of their existence is stored up in the geological formations, yet far down in the early sedimentary rocks have been discovered fossil remains of the simpler forms of radiates, molluscs and articulates, all believed to have originated from one common parent.

Millions of years again rolled round, sufficient to have formed a series of deposits several thousand feet in thickness, and known as the old red sandstone. Here, in addition to the forms of life already noticed, is found the first trace of fishes, the lowest of all vertebrates. From the evidence to which this series of rocks bears

witness, the seas at that time must have swarmed with these animals. The lower or cartilaginous fishes appeared first; the bony forms, later. Faint traces of marine plants have also been discovered in the same strata.

Following the era of the old red sandstone came that known as the carboniferous period, one of great duration and closing the palæozoic age, and in which appeared limestone and coal beds. This period was characterized by remarkable vegetable growths, from the vast accumulations of which were formed the coal fields now furnishing the fuel of the world.

Millions of years again pass away. New strata are formed, and the Secondary or Mesozoic age appears. This geological period exhibits the first appearance of land animals, particularly of reptiles, with the first traces also of birds. Reptiles of enormous size and extraordinary structure were numerous, as shown by fossil remains. The tracks of birds indicate the first appearance of these animals during this period. Here, for the first time, in addition to the remains of invertebrates, with those of fishes, reptiles and birds of the vertebrate series, we get a glimpse of the highest of vertebrates, the mammalia, in the remains of portions of a marsupial, an animal of that class forming a connecting link between birds and mammals.

In the Cretaceous period, which follows that of the Oolite, fossils are numerous and varied. The remains of birds are sufficiently frequent to show that they had

reached a high degree of development, while the remains of mammals are few.

Again millions of years come and go, and another series of stratified rocks appears, known as the Tertiary. Here is found an entirely new series of animals. Many of the earlier forms have apparently become extinct, new ones taking their place. Mammals and birds have become abundant. In the Eocene, the oldest subdivision of this period, have been found the remains of more than fifty species of mammals, all of which have long been extinct, and the most of which were monsters in size. Many new reptiles now appeared as well as birds, including species allied to the quail, buzzard, owl and pelican, also mammals related to the opossum, raccoon and squirrel, as well as the fox and wolf.

In the Miocene subperiod a still further development of now extinct monsters is found. In that period also are found animals allied to the bear, the dog, the horse, the hog, and also the first races of the felinæ, of which the cat is the type. Abundance of marine animals appear also during this period, including seals, dolphins, walruses and whales.

In the Pliocene subperiod of the tertiary formation we find still more remarkable evidences of mammalian development. The pachydermatous monsters of the period have disappeared, and in their places are found others belonging to still existing species—the elephant, hippopotamus and rhinoceros. Belonging to the extinct animals of this period also are the mammoth and

mastodon, remains of which are frequently found in this country. For the first time, the pliocene division of the tertiary period gives us also the ox, deer and camel, with other specimens of the ruminantia, as well as many carnivora. The same period gives us also the first indication of the approach of the quadrumana in a few remains of animals of the monkey family, found in England, in Europe, Asia and South America. Finally, within recent times, stone implements, plainly the work of man, are claimed to have been discovered in the *upper* pliocene strata, giving evidence of the existence of man on our earth at that early day.

We now come to the last era in the development of our earth, that known as the post-tertiary or quaternary period. This brings the earth's history down to the present time. It is usual to divide this age into the glacial and recent, or human.

Evidences have been found of a gradual lowering of the temperature near the close of the tertiary period. The climate continued to become more and more frigid, until the glacial period was fully established, and vast fields of ice and snow, hundreds of feet in thickness, covered all the northern portions of Europe, Asia and North America. The duration of the glacial period is estimated at thousands, if not hundreds of thousands, of years. The climate finally became slowly warmer. The great fields of ice gradually melted away, leaving evidence in the beds of gravel and scattered boulders of the transporting power of the ice of this period.

Following this period came a general subsidence and submergence of the continents. Vast icebergs floated over the land, depositing as they melted the numerous accumulations collected from northern coasts upon which they were formed, thus adding to the deposits of gravel and the scattered boulders so numerous in many northern climates.

Finally, by a slowly returning elevation, the waters receded, and our earth was left much in the condition seen at the present time. The fossil remains of this period are found mainly in caves, filled-up lakes, in the alluvial deposits on the borders of rivers, marl and peat beds, and in the vegetable soil. They include many extinct species of animals, with the remains of many of those still living. The evidences of the existence of man now become numerous and positive. Whether the evidences of his appearance late in the Pliocene period are reliable or not, remains of his workmanship show his early and extended distribution in the Quaternary period.

The human period of the earth's history extends from the earliest appearance of the remains of man down to the present time. It is usually divided into the prehistoric and historic ages, the only records of the former being the remains of the implements employed by early man, with a few specimens of his petrified bones. The period has been divided into the Stone, the Bronze and the Iron ages, according to the character of his implements: the present, or historic, age having also

been denominated the age of Steel. The first, or Stone age, judging from the number and wide distribution of the stone implements of this period, was of vast duration. Rudely-formed stone knives, axes, arrow and spear-heads, hammers and polishing stones, were man's first and only implements. He lived in caves or in the rudest kinds of huts. He had no domestic animals. He did not cultivate the earth. He had no government and no society, yet he lived and possessed the earth for thousands if not millions of years. At whatever point he may have originated, he spread to every continent and every large island, and held possession for such a period of time as to have left behind him remains of his simple stone implements, in such quantities and in such wide distribution as to have become a source of wonder and astonishment.

Finally he discovered copper and other ores, learned to manufacture them into implements of various kinds, and thus came the age of Bronze. Still later, he began to smelt iron, and from this more useful and more widely distributed metal he fashioned implements of warfare and of the chase. Thus came the age of Iron.

The manufacture of pottery was also one of the early acquired arts of our ancestors. At first they manufactured vessels of the rudest forms, and simply dried them in the sun; later they were baked in fires, becoming thus far more useful, and so much less perishable as to have become valuable additional records of the history of the development of man.

It has been mainly from these enduring remains of the workmanship of early man, as found in the various geologic strata, that we have been able to form an estimate of the time of his appearance, of his gradual development, and of his cotemporaneousness with various now extinct animals.

We have seen that an examination of the fossil remains of the earth's crust reveals a gradual and slow development of higher and higher organic beings, both vegetable and animal. The oldest strata of the Palæozoic age exhibit the simplest forms of radiates, molluses and articulates, these, for ages, being the only representatives of animal life. New species gradually formed and disappeared, each step advancing to a higher plane of development. Finally, as early as the period of the Old Red Sandstone, vertebrates of the lowest forms appeared—those of fishes—these being followed, in the secondary period, by reptiles and birds, and finally by mammals in the Tertiary period, and lastly by man.

It is an interesting and highly suggestive fact that, connecting the several orders of animals, both in the geologic past as well as in the present time, are certain intermediate forms uniting fishes to reptiles, reptiles to birds, birds to mammals, as well as mammals to man, bringing the connective link in many cases in such relation to the order below and that above as sometimes to give doubts as to its true position in the series. Thus, batrachians plainly form a connecting

link between fishes and reptiles. Fossil remains have also been discovered of an animal of the past with the jaws and teeth of the reptile and the wings and feathers of birds, an animal plainly intermediate between birds and reptiles. Again, the monotremata of Australia, in their single excretory outlet, the manner of production of their young, their webbed feet and flattened bills without teeth, plainly establish a connecting link between birds and mammals. And lastly, the quadrumana as clearly unite man to lower orders of mammals.

On the theory of the gradual development of all higher forms from lower, these facts are intelligible enough, while the doctrine of a special creation for each species, in their almost endless variety, suggests a great waste of creative energy, or a bungling experimentation in endeavoring to arrive at satisfactory results. It will be admitted that it would have been no more difficult for the Divine Being to have created laws by which the whole animal and vegetable series might have been developed from a single original cell than for the individual animal or plant to be developed as we see them to-day. Evolution teaches that such laws do exist, that the evidences of their existence in the geologic past are unmistakable, and that the same forces that have produced such wonderful results in the past are in full operation to-day.

Let us here inquire into the nature of the several factors claimed to have been active in the evolution of higher from lower organic forms.

First.—The inherent tendency of all organic beings to slight variations in structure constitutes the first and most important factor working toward the development of new species. We see this tendency daily in the domestic animals. These variations may be slight, yet if transmitted to future generations by inheritance, and if sufficient to give certain advantages to individuals, we can understand that in time the variation may become permanently established, or even so extended as to result in marked changes in the form and character of the race.

Second.—The "struggle for existence" on the part of organic beings has been found to exert a powerful influence in the preservation of such accidental variations of structure as may give slight advantages to the individual. Thus, plants on the border of a desert may be said to struggle for their existence against the drought. Such as have the power to send their roots to a greater depth may survive, while all others perish. So animals, in a time of scarcity of food, are subject to a similar struggle; those possessing some slight advantage in size and strength, or cunning, surviving, while others perish. The influence of this struggle has always tended to develop and perpetuate such modifications of form as might tend to give advantages to the individual.

Third.—"Natural selection" and "survival of the fittest" express another of the important influences operating to preserve and perpetuate such variations

as may appear in animals or plants. As is well known, man has it in his power to cultivate and preserve all such modifications in the domestic animals as may best serve his purposes. Thus the several breeds of horses, including the heavy draught-horses, racers and trotters, have all been developed by careful breeding from one original form. So nature, by the process of "*natural selection*," improves and modifies, and in process of time develops and permanently establishes, new varieties and even new species. Again, heredity and the influence of environment have been additional important aids in the work of evolution.

Lastly comes the all-important factor of unlimited time. As the mills of the gods are said to grind slowly but very fine, so Evolution has required its myriads of ages and an endless series of lives for accomplishing its results. In evidence of the vast periods of time that were required to produce the present condition of the earth, I may mention that on the eastern coast of England a rocky cliff presents evidence of having been worn away by the action of the waves for a distance of several miles. It has been estimated by careful observers that the denudation has been at the rate of about one inch in a century. At this rate the wearing away of this line of coast must have required 306,662,400 years; and yet we are told that this vast period is a mere trifle in comparison with that required for the wearing away of certain palæozoic strata at least 10,000 feet in thickness.

"The consideration of these facts," says Darwin, "impresses the mind almost in the same manner as does the vain endeavor to grapple with the idea of eternity itself."

Let us next inquire: What are the evidences that animals, and especially man, have originated in this manner? First may be offered the facts recorded in the volumes of geologic strata of the earth's surface. We have seen that the older the strata, the simpler the animal forms preserved therein; that in later periods old forms have passed away and more highly developed ones appeared, the series thus presenting one continual, graduated, ascending scale, ending finally in man. (See table, page 4.) When we reflect that every individual member of living species has originated by a process of evolution from a minute germ, and without the exercise of any direct creative power, but through the influence of established law, why should we have difficulty in accepting the theory that the earliest animals, with their various species, as well as man, may have originated in a similar manner.

It is admitted that the geologic records are incomplete; that many links in the chain of evidence are missing, and that there are difficulties in the way of accepting many of the facts of geology. Yet time and more careful explorations are giving increasing light upon the subject, and every new discovery seems to strengthen and confirm the theory of evolution.

Again, the facts of embryology offer us the strongest

arguments in favor of this doctrine. Man is developed from an ovule about the 125th of an inch in diameter, which in no respect differs from the ovule of most other animals. Again, the embryo of man, up to a certain period of development, can scarcely be distinguished from that of a fish, a reptile, a bird, or from that of any other mammal. Take a series of ova from each of these great classes of vertebrates, and compare the progress of their development. The steps of the process are the same in the fish, the reptile, the bird, the mammal, including man. Certain arterial arches in connection with the main bloodvessel appear in all. In the first, these remain as a permanent structure, carrying the blood to the gills. Again, slit-like openings in the neck appear in all. In the fish these remain as gill openings, while in the higher forms both the openings and vascular arches gradually disappear.

Again, at a later period, the feet of reptiles and mammals, the wings and legs of birds, as well as the feet and hands of man, all arise from the same fundamental forms, and at one time are indistinguishable one from the other. The human heart, also, in its development, passes successively through all the stages of growth found as permanent forms in the lower animals. It first appears as a simple pulsating vessel, as in the invertebrates; next as a simple heart of two cavities, as in fishes; a little later presenting three cavities with the same character of circulation as in

reptiles, and not until the time of birth does the perfect heart of four cavities, as found in birds and mammals, fully appear.

Again, in the development of the human brain, it at one time strongly resembles that of lower vertebrates and is destitute of convolutions. At seven months it has reached the stage of development corresponding to the permanent condition of the adult baboon.

So the presence of rudimentary organs as found in all the lower animals, as well as man, presents a powerful argument in favor of the theory of descent from lower forms. Some of these cases are extremely curious. Thus in the fœtal whale rudiments of teeth are found in the jaws, though the adult whale has not a tooth in his head. The upper jaws of unborn calves show the presence of rudimentary teeth which never come to the surface. We speak of certain things being as scarce as hens' teeth, yet rudimentary teeth have been found in the jaws of birds, suggestive of their descent from reptiles, all of which have teeth.

We all have noticed the power certain animals have of moving the skin. This is the result of the action of certain muscles, rudiments of which are seen in the platysma myoïdes of man, a muscle usually too feebly developed to be of any service to him. Giving the power in many lower animals of turning the external ear in different directions, are certain muscles found also in man, but in such a rudimentary condition as to be utterly useless to him. All the lower animals have

some kind of covering,—fishes and reptiles have scales, birds have feathers, and mammals have hair; yet man is naked when born. Still we find upon his body, evidence of his descent from some hair-covered animal, in the short scattered hairs in the male and fine down on the female. We notice also considerable variability in this hairy development in different individuals, and in different nationalities.

It appears also that the posterior molar, or wisdom teeth, are gradually assuming a rudimentary condition. In earlier ages they presented three roots; they now have but two, these sometimes being fused into one. They are the last to appear, and usually the first to decay, and occasionally never appear. The gradual shortening of the jaw, from diminished use in civilized man, leaving less room for the molars, is, no doubt, the principal cause leading to this result. That fold of the mucous membrane at the inner canthus of the eye, and known as the plica semilunaris, is also considered as a rudiment of the membrane nictitans, a third eyelid found in many birds, also in certain reptiles and fishes, and again in the lower mammalia, as in the monotremata and marsupials.

One of the most interesting examples of a rudimentary organ in man is the vermiform appendage of the cæcum. Of great length and size in many of the vegetable-feeding animals, apparently from a change of diet, the cæcum has become much shortened in many animals, the appendage being left as a rudiment of the

shortened intestine. It is subject to a considerable variability in size in man. Usually three to four inches in length, it is sometimes much shortened, sometimes closed for more than half its length, occasionally completely absent, and destined, no doubt, in the future, to wholly disappear.

I shall refer to but a single additional rudimental structure in man, and that is the supracondyloid foramen. In the quadrumana and in some other orders of the mammalia, particularly the carnivora, there is found a foramen at the inner border of the humerus, above the condyle, and known as the supracondyloid foramen. When present in these animals, it transmits the median nerve and brachial artery, one or both. Occasionally in the humerus of man a trace or remnant of this structure is found in the presence of a hook-like process of bone, which by means of a ligament stretching from its apex to the inner condyle, forms a foramen through which the great nerve passes. In the present age, this rudimentary structure is found to occur in about one per cent. of human skeletons. In a collection of skeletons from an old cemetery in Paris, the perforation occurred in four and one-half per cent. of the arm bones, while as high as thirty per cent. of perforated bones have been found in caves containing the remnants of the stone age of man.

The leaning of the three great classes of facts to which I have called your attention is unmistakable in its direction. They point directly and emphatically to

the descent of man from lower animals. No other satisfactory explanation ever has or can be given for the manner of man's development or for the rudimentary organs found in his body.

While evolution has been widely accepted by the scientific men of this and other countries, it has met with bitter, yet gradually yielding, opposition from the Church and theologians. They tell us it is unreconcilable with the teachings of the Bible, that it robs God of his power as Creator, and degrades man from his high position to the level of the common brute. Equally strong prejudice on the part of theologians against the revelations of science has been overcome in the past, and that against evolution is destined to receive the same fate. A more liberal interpretation of the symbolic and metaphoric language of Scripture has led to the acceptance of many scientific positions supposed to have been at variance with revelation, and, without doubt, similar concessions will be made in favor of evolution.

Does the fact that the adult man has been developed from a callow youth, the youth from a puling infant, the infant from a fœtus, the fœtus from a shapeless embryo, the embryo from an almost structureless microscopic atom of protoplasmic matter, all through the direction of universal law, make him any the less a creature of God, or detract from the power or wisdom of the Almighty? Or would the origin of the first man by slow, successive steps of evolution from lower

forms of animals, all in conformity with God-made laws, detract in the least from the dignity of man, or rob the Deity of his power and glory?

In a recent address before the Brooklyn Ethnological Society by Professor Fisk, of Harvard University, he closes in these words: "The doctrine of evolution, which affects our thought above all things, brings before us with vividness the conception of an ever-present God—not an absentee God who once manufactured a cosmic machine, capable of running itself, except for a little jog or poke here or there in the shape of a special Providence. The doctrine of evolution destroys the conception of the world as a machine. It makes God our constant refuge and support, and nature his true revelation; and when all its religious implications shall have been set forth, it will be seen to be the most potent ally that Christianity ever has had in elevating mankind."

Thus, while some have claimed that evolution is wholly materialistic in its influence, others are equally positive that it in no way conflicts with a liberal interpretation of Scripture, and that it is calculated to give a more exalted conception of both God and man. One of the strongest believers and supporters of this theory, of my acquaintance, is a prominent clergyman of this city, and he finds no difficulty in harmonizing its teachings with his views of Divine revelation.

When we reflect upon the vast progress made by the universe and man, when we compare the present con-

dition of man with what he was a few thousand, or even a few hundred, years ago, when we remember that it has been through one steady, onward march of progress that man has reached his present condition, the query naturally arises: Has the climax of development been reached? Has evolution advanced to the last point? Or, is progress to continue in the future as in the past? The same tendency to variation of structure exists as of old. The laws of heredity, the influence of environment, the tendency of "survival of the fittest," and all those forces that have aided in producing the grand results of the present, are still in full operation; and as, without doubt, there is the same immeasurable future in which these forces may continue to work as they have in the past, we must conclude that the goal has not yet been reached, and that there is before us a future of progress of which we can form but the faintest conception. What a field is here offered for the fertile imagination! In the progress of continued development, the future man, without doubt, will lose all his rudimentary structures. If he acquires no new organs or senses, we may conceive that those he now has may be vastly improved. His better knowledge of nature and disease will secure him better health and longer life. His discoveries and inventions will so eclipse those of the present time as to enable him to accomplish results of which we can form but the faintest conception. He may acquire such control of the elements as to enable him to modify the temperature, the moisture and the

general character of the weather. He will navigate the air with the same facility as he now does the seas. He will explore the bowels of the earth and utilize its internal fires. He will develop new sources of energy, and accomplish results in days, now requiring months or years. The chemistry of his laboratory will supersede much of that of nature. He will produce his perfumes without the aid of flowers, and will manufacture much of his food from the raw inorganic elements, without waiting for the slow processes of vegetable and animal growth. Physically he will be better developed, mentally more active, and morally more perfect. Surely, the future of man is full of hope, and who can foresee the limits of his destiny?